Preparation of a Microchannel Plate Detector for Use at the 88-Inch Cyclotron

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In order to focus a beam of particles, and thus insure that the optimal number of particles strikes a target in use, one must be able to detect the beam. At the 88-inch cyclotron, a beam is usually imaged with a phosphor. The charged particles activate the fluorescent material, and the image is seen in the control room via a video camera. This procedure works very well for typical stable beams, but not for radioactive ion beams (RIBs), where in most cases the intensity of the beam is too low to activate the phosphors. A position sensitive microchannel plate detector (MCP), with sensitivities of 10^1 – 10^2 ions/sec in the integrated signal and 10^4 ions/sec in the imaging mode, can replace the standard phosphor for low intensity RIBs. A system that was designed at HRIBF [1] has been adapted to the 88-Inch Cyclotron facility.

The detector – a Model 3390 Quantar Technology MCP RAE sensor – has an active diameter of 2.5 cm and consists of four layers. There is a thin metal disk sandwiched between two microchannel plates, and there is a resistive anode located behind the plate/disk sandwich. The anode is where the output signals are generated. Each plate consists of about 10^6 glass tubes, 10 - 100 μm in diameter. [2] Each of these acts as a small Geiger tube, creating an electron cascade for every electron incident on the plate. The incident electrons are produced when the beam hits a thin carbon foil, and they are then deflected to the front face of the detector by a magnetic field generated by two permanent magnets. The generated electrons are accelerated through the four stages of the detector by positive DC voltages which increase from one layer to the next.

The four anode signals pass through fast preamplifiers and are fed into a position analyzer. Through software developed at ORNL, the image of the amplified beam can be viewed in real time. This will be implemented in the future.

Figure 1 shows a picture of the mounted MCP detector. The foil is in its lowered position to be out of the way of the beam. When raised by the rod shown, it subtends an angle of 30 degrees relative to the beam, at which the maximum number of production electrons is achieved[4]. The MCP and the two permanent magnets above and below it are also parallel to the foil.

Footnotes and References

[1] D. Shapiro et al, NIM **A454,** 409 (2000)
[2] J.L. Wiza, NIM 162, 587 (1979)

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Figure 1. A photo of the multichannel plate detector and foil mounted in an 88-Inch Cyclotron beam box before installation in a beamline.